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Schumann Resonance on Mars: A Tool for the Investigation of the Electrical Properties of the Martian Environment

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Schumann resonances (SR) are global resonances of electromagnetic waves in the range of extremely low frequencies (ELF) propagating in a planetary cavity. This spherical waveguide is formed by the ground and the lower ionosphere. SR are supposed to occur on Mars, although many electrical properties of the Martian environment are still not well-determined. One of the most important problems in the SR modeling on Mars is to estimate electrical properties of the Martian ground and their influence on ELF waves propagation.

In our previous study we have developed an analytical model of the ground–ionosphere waveguide based on the characteristic electric and magnetic complex altitudes' formalism, which has allowed us to take into consideration the Martian two-layered ground.

In this work we have carried out simulations in order to determine the influence of the electrical properties of the Martian cavity on ELF waves propagation. We obtained results for several cases in which different electrical properties associated with the Martian atmosphere and ground were considered. Particularly we discussed the SR spectra obtained for the cases of low-conductive surface layers, and high-conductive subsurface layers of various depth. In addition we estimated the threshold value for the volumetric size of hypothetic groundwater reservoirs above which they could be detected using the SR phenomenon.

The results point out the importance of studying SR on Mars and the need for the in situ research on propagation of ELF waves in the Martian environment. The measurement of the resonance field on Mars is associated with a necessity to locate an ELF receiving system at the planetary surface. The heaviest part of such equipment are two orthogonal magnetic antennas of an adequately high sensitivity. We have discussed the issue of sending such instruments to Mars. We also proposed an uncomplicated way to measure the electrical properties of the Martian cavity.